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ABSTRACT

The effects of overt, covert, and summary practice conditions on four levels of learning were examined. One hundred twenty-two middle class sixth-grade students were randomly assigned to practice condition. Passages about energy sources were read by the students and oral reviews were directed according to treatment. The summary group was given a review of relevant content, while covert and overt groups responded to adjunct questions. A 32-item selected response test contained 16 items from the practice booklet and 16 new items not practiced by any treatment. Data were examined on four dependent measures: repeated fact, new fact, repeated inference, new inference. The results show that oral summaries of relevant information can be as effective as inserted questions on immediate and delayed test performance. This study suggests that practice condition and question type may differentially affect learning and retention. (31 references) (Author)

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Factual and Inferential Learning Under Varying Levels of Information Processing

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FACTUAL AND INFERENTIAL LEARNING UNDER VARYING LEVELS OF INFORMATION PROCESSING

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ABSTRACT

The effects of overt, covert, and summary practice conditions on four levels of learning were examined. One hundred twenty two middle class sixth grade students were randomly assigned to practice condition. Passages regarding energy sources were read by the students and oral reviews were directed according to treatment. The summary group was given a review of relevant content, while covert and overt groups responded to adjunct questions. A thirty two item selected response test contained sixteen items from the practice booklet and sixteen new items not practiced by any treatment. Data were examined on four dependant measures (repeated fact, new fact, repeated inference, new inference). The results show that oral summaries of relevant information can be as effective as inserted questions on immediate and delayed test performance. This study suggests that practice condition and question type may differentially affect learning and retention.

Introduction

Cognitive theory generally holds that recall of textual information is strongly affected by the level of information processing (Craik & Lockhart 1972, Bretzing & Kulhavy 1979). Based on the theory that recall of textual information is a function of processing it was predicted that as reading comprehension tasks demanded a more complete interaction of the reader's existing schemata, and as the subjects were more actively involved in the learning process, higher levels of recall would be found (Glover 1982).

An underlying assumption in most practice condition research is that questions are beneficial to learning. Andre (1979) found that questions influenced the nature of the memory representations formed during instruction and that these representations controlled the way in which stored knowledge was used. Andre and Sola (1976), and Andre and Womack (1978)

suggested that adjunct paraphrased questions guide semantic encoding of presented information and thereby lead to greater performance.

Many studies have demonstrated that treatments involving questions result in higher learned performance (Anderson & Biddle, 1975). After reviewing the research in this area, Dillon (1982) reported that adjunct questions had a consistent, but small, positive effect on the retention of information.

Two common practice conditions currently in the research are overt (verbal or written responses) and covert (internalized responses). Subjects in studies comparing the effects of these practice conditions have been typically presented written or verbal questions.

Many studies (Goldbeck & Campbell, 1962; Holland, 1960; Michael & Maccoby, 1961) have shown that both covert and overt responses facilitate student learning. Research has indicated that when verbalization follows an instructional segment, both question relevant and incidental subject content learning improve (Hershberger, 1964; Frase, 1968 & 1970).

Alternatives to the non-question control group have been used in many studies (Buggey, 1971; Ryan, 1973). Winne (1979) suggested the use of a summary group as a realistic classroom approach and non-question treatment. Research, however, has provided little information about the effects of such treatments.

Numerous studies have shown no significant differences between higher-cognitive and fact question teaching strategies (Andre, Mueller, Womack, Smid, & Turtle, 1980; Ryan, 1974; Bedwell, 1975; Savage, 1972). Others too have asserted that higher-level questions have little demonstrated relationship to student achievement (Gall 1970; Dunkin & Biddle, 1974). Frase (1968) reported that broader questions do not direct the learner's attention and therefore lead to poorer performance.

Some studies, however, have shown that application-type review questions facilitate a higher-order learning because they require the learner to apply acquired information to new situations. Yost, Avila, and Vexler (1977) reported that as the complexity of questions to which students responded increases, achievement increases. Their study found that higher-order questions generally facilitated posttest performance by directing attention to more information.

Differential effects for reading ability are well supported in research on adjunct questions. High readers generally score higher on content relevant tests than low readers. Question placement and question type greatly affect results (Richards & Di Vista, 1974). Many studies have found facilitative effects of questions across reading levels.

Experimental studies investigating immediate and delayed criterion test scores have revealed differential effects for

practice condition and question type. Overt and covert responses have been equally beneficial when testing occurs immediately following instruction (Kanner & Sulzer, 1956). However, time delay in the administration of the criterion measure has revealed that overt responses are significantly more effective than covert (Goldbeck & Campbell,1962). Anderson (1970) states that due to depth of processing, higher-cognitive questions are retained longer than lower-cognitive questions.

The purpose of this study was to investigate the effect of overt, covert, and summary conditions on four levels of student learning. A 32 item posttest assessed the following: factual information presented and practiced in the instruction (repeated fact), factual information presented but not practiced in the instruction (new fact), information directly inferable and practiced (repeated inference), information directly inferable but not practiced in the instruction (new inference).

Method

Subjects

The original sample consisted of 148 sixth grade students from two elementary schools that served middle class suburban populations and were of equal size. Twenty six subjects were dropped from the study for absence from an experimental session or for failure to complete the attitude inventory. The final sample had a total of 122 subjects.

Materials

An instructional passage consisting of approximately 1100 words was adapted and modified from the "Power Switch" unit of the Energy Source Program (1982). Passages described eight potential energy sources of the future. The text was divided into nine sections, each containing two or three paragraphs. Paragraph length ranged from 50 to 65 words. The readability level of the material was 5.8 as determined by Brown's (1965) science text adaptation of the Dale-Chall readability formula.

Treatment booklets were developed for specific use in the three different practice conditions. Summary group booklets consisted of text only, while covert and overt group booklets contained adjunct questions. Inserted questions were located immediately after each passage. Booklets were 19 pages in length.

An introduction was included in all booklets. All groups were allowed practice on both factual and inferential questions.

Questions used in this study were submitted to experts who verified that inference questions did indeed require students to come to logical conclusions by using the information presented. Fact questions were found to require only simple verbatim recall from text.

Questions and text were submitted to a panel of five Educational Technology PhD candidates. They concurred that the inference questions could be answered by using only the information in the passage. They agreed that there was one best answer of the selected responses, and that distractors met instructional design criteria.

The questions for this study were first pilot tested with a group that did not read any of the passages. Questions used in this experiment were those which students received a chance percentage of approximately twenty-five percent correct. The items and text were then presented to fifty-one subjects who read the materials silently and answered all questions. From results of this pilot test, a pool of fact and inference questions, with overall equivalent difficulty and discrimination indices, was constructed.

The criterion test consisted of 32 items. Sixteen of these were new items and 16 were repeated from the text. Fact and inference items were represented equally and covered the same material but were not parallel questions.

Procedures

Subjects were ranked as high, medium, or low readers by their teachers. Standardized scores were not used for leveling subjects because this information was not made available at both schools. Groups were blocked for reading level and sex and subjects were randomly assigned to groups.

The three treatments were administered by PhD candidates trained in the experimental procedures. Each experimenter was randomly assigned to a group and presented the same practice condition to both schools.

During the experimental session all students were directed to their assigned classrooms. Experimenters handed out a pre-coded packet to each subject. All students received the same general instructions including a brief lesson and practice in answering fact and inference questions. Scripts for experimenters specified content, style of delivery, verbatim phrasings, and the sequence of questions to be asked.

Covert and overt groups were exposed to text, given a question to answer, and were called on by the experimenter to answer the question. Knowledge of correct response was summarized by the experimenter before proceeding to the next passage. The overt group was instructed to write responses on

the line at the bottom of each page. The covert group was told to mentally select the best answer. Questions were purposely not labeled with a, b, c, or d. Therefore, when practicing responses or reporting to the group, students were required to repeat the answer itself and not simply the corresponding letter or number. The experimenter always responded to student answers according to the script. Both question groups received corrective feedback but no supplemental information.

The experimenter presented a scripted review to the summary group. This review covered the same facts and concepts as mentioned in questions given to both question groups. All information was presented in declarative form. Treatment time for both question groups was approximately one hour and 15 minutes. The summary group, which did not require teacher wait time for selection of answers, calling on students, or giving knowledge of results, took only fifty minutes. The immediate criterion test was administered when each group finished the materials. The delayed test was given exactly one week later.

Criterion Test

The 32 item selected response criterion test consisted of 16 repeated items, from question group booklets, and 16 new items. Half of the items were fact questions and half were inference questions. The immediate test and delayed test were identical.

Design and Data Analysis

A 3 (practice condition) X 3 (reading level) factorial design was used. Data were examined with four dependent measures (repeated fact, new fact, repeated inference, new inference). Each multivariate analysis of variance was followed by a univariate analysis. Immediate and delayed tests were reviewed separately.

Results

Mean scores by practice condition, question type, and reading level on the 32 item immediate test are presented in Table 1. Table 2 displays the mean scores for the delayed test. A summary table for univariate and multivariate analysis of variance is shown on Table 3.

Results are discussed below by immediate test, delayed test, and gain scores.

Table 1

Mean Scores on Immediate Test

Reading Level and Condition		Fact: Repeated Items	Fact: New Items	Inference: Repeated Items	Inference: New Items	Grand Total
High						
Overt	x	7.18	4.71	6.59	4.35	22.82
	SD	.73	1.40	1.28	1.50	3.63
Covert	x	7.08	4.92	5.83	4.33	22.17
	SD	1.16	1.56	1.64	1.23	4.30
Summary	x	5.92	6.15	6.38	5.77	24.23
	SD	1.26	.90	1.45	1.42	3.75
Medium						
Overt	x	5.82	4.88	5.53	3.71	19.94
	SD	1.85	1.76	2.18	1.36	5.10
Covert	x	5.73	4.33	5.00	4.27	19.33
	SD	1.91	1.95	2.27	1.91	6.06
Summary	x	5.06	5.94	4.94	4.76	20.71
	SD	1.52	1.03	2.30	1.79	4.70
Low						
Overt	x	5.27	3.36	4.09	3.36	16.09
	SD	1.56	2.38	1.38	1.43	5.36
Covert	x	4.40	3.50	3.30	2.70	13.90
	SD	2.55	1.65	2.06	1.42	5.49
Summary	x	3.10	4.30	3.70	3.10	14.20
	SD	1.97	1.25	1.64	2.47	6.21
Total	x	5.64	4.78	5.19	4.13	19.74
	SD	1.94	1.76	2.09	1.79	5.18

Practice Condition	
Overt	20.09
Covert	18.79
Summary	20.23

Reading Level	
High	23.07
Medium	20.02
Low	14.77

Question Type	
Fact	10.42
Inference	9.32

Immediate Test

Practice condition

As shown in Table 1, the mean scores for the immediate criterion test were 20.09 for overt, 18.79 for covert, and 20.23 for summary groups. The multivariate analysis of variance (Table 3) revealed a significant effect for practice condition ($F(8,222) = 6.02$, $p < .0001$).

Scheffe's multiple comparison test found significant differences on repeated fact and new fact items, but not on repeated inference or new inference items. On repeated fact items, the mean scores of 6.20 for the overt treatment and 5.81 for the covert treatment were significantly higher than the mean of 4.85 for the summary group, $F(1,113) = 3.07$, $p < .05$. On new fact questions the situation was reversed. The mean of 5.60 for the summary group was significantly higher than the means of 4.44 for the overt treatment and 4.29 for the covert treatment, $F(1,113) = 3.07$, $p < .05$.

Reading Level

Significant effects for reading level, $F(8,222) = 5.88$, $p < .001$) on the immediate test were supported by univariate F-tests with significance on all four dependent measures, $F(2,113)$, $p < .0001$. High readers (23.07) and middle-level readers (20.02) scored significantly higher than low readers (14.77) on new fact, repeated fact, new inference. and repeated inference items, $F(1,113) = 3.07$, $p < .05$. High readers scored significantly higher than middle-level readers on only the repeated fact and repeated inference questions, $F(1,113) = 3.07$, $p < .05$. This held true across practice conditions.

Question Type

The difference on overall performance on fact questions (10.42) and on inference questions (9.32) was statistically significant, $F(1,120) = 119.13$, $p < .001$. The correlation of F1 (immediate fact questions) with I1 (immediate inference questions) was .85.

Interactions

Multivariate analysis of variance revealed no signi'icant interaction effects for the immediate test.

Table 2

Mean Scores on Delayed Test

Reading Level and Condition		Fact: Repeated Items	Fact: New Items	Inference: Repeated Items	Inference: New Items	Grand Total
High						
Overt	x	6.59	5.00	6.76	5.35	23.71
	SD	.94	1.70	1.40	1.27	3.80
Covert	x	6.08	5.17	5.17	3.92	20.33
	SD	1.91	1.80	1.99	1.38	6.18
Summary	x	5.15	5.31	5.62	5.92	22.00
	SD	1.91	1.70	2.02	1.32	5.64
Medium						
Overt	x	5.41	4.00	4.76	3.29	17.47
	SD	2.00	2.03	2.28	1.36	6.24
Covert	x	5.00	3.53	4.47	3.60	16.60
	SD	1.96	2.10	1.88	2.03	5.93
Summary	x	4.47	5.34	4.71	5.41	19.82
	SD	1.70	1.48	1.86	1.58	4.42
Low						
Overt	x	3.91	3.45	4.09	3.00	14.05
	SD	2.77	1.29	1.30	1.90	4.27
Covert	x	4.50	3.00	3.80	2.70	14.00
	SD	2.55	2.00	1.93	1.06	5.48
Summary	x	2.30	2.60	2.40	2.80	10.10
	SD	1.25	.84	.84	2.10	3.87
Total	x	4.97	4.26	4.80	4.14	18.16
	SD	2.20	1.92	2.07	1.92	6.35

Practice Condition		Reading Level		Question Type	
Overt	18.99	High	22.21	Fact	9.23
Covert	17.10	Medium	18.02	Inference	8.94
Summary	18.10	Low	12.90		

Table 3

Source Table for Univariate and Multivariate ANOVA for Fact and Inference Questions

Source of Variance	Question Type	df	MS	Univariate F	p<	*Multivariate Approximate df	*Multivariate Approximate F	*Multivariate Approximate p<
Immediate Test								
Practice Condition	FR1	2	20.92	7.82	.001	8	6.02	.001
	FN1	2	17.92	7.15	.001			
	IR1	2	4.78	1.37	.259			
	IN1	2	7.37	2.76	.068			
Reading Level	FR1	2	54.07	20.22	.001	8	5.88	.001
	FN1	2	23.86	9.52	.001			
	IR1	2	58.36	16.69	.001			
	IN1	2	27.95	10.46	.001			
Condition by Level	FR1	4	1.73	.65	.629	16	.70	.792
	FN1	4	.92	.37	.830			
	IR1	4	.38	.11	.980			
	IN1	4	3.01	1.12	.348			
Within Subject Error	FR1	113	2.67					
	FN1	113	2.51					
	IR1	113	3.50					
	IN1	113	2.67					
Delayed Test								
Practice Condition	FR2	2	21.18	5.51	.005	8	4.78	.001
	FN2	2	2.14	.72	.491			
	IR2	2	10.40	3.19	.045			
	IN2	2	16.32	6.57	.002			
Reading Level	FR2	2	49.67	12.92	.001	8	5.62	.001
	FN2	2	40.41	13.50	.001			
	IR2	2	52.01	15.93	.001			
	IN2	2	43.91	17.68	.001			
Condition by Level	FR2	4	2.45	.64	.637	16	1.24	.231
	FN2	4	5.31	1.77	.139			
	IR2	4	4.79	1.47	.217			
	IN2	4	7.23	2.91	.025			
Within Subject Error	FR2	113	3.85					
	FN2	113	2.99					
	IR2	113	3.27					
	IN2	113	2.48					

*The Multivariate F value reported is Pillais' approximate F.

Delayed Testing

Practice Condition

As shown in Table 2 the mean scores for the delayed test were 18.99 for overt, 17.10 for covert, and 18.10 for summary groups. A significant effect was obtained for practice condition, F (8,222)= 4.78, $p<.001$. The overt group outscored the summary group which in turn scored higher than the covert group. This delayed finding differed from the immediate test results which favored the summary group over both the overt and covert practice groups.

The analysis of performance by type of question yielded differences for repeated fact and new inference questions. On repeated fact items, the mean scores of 5.49 for the overt treatment and 5.22 for the covert treatment were significantly higher than the mean of 4.15 for the summary group, F (1,113)= 3.07, $p<.05$. Both practice groups also had significantly higher scores than the summary group for repeated fact items on the immediate test.

On new inference items, the mean score of 4.93 for the summary treatment was significantly higher than the mean scores of 4.00 for the overt treatment and 3.46 for the covert treatment, F (1,113)= 3.07, $p<.05$. Scores did not differ significantly between groups on new inference items on the immediate test. There were no significant differences on the delayed test on either new fact items or repeated inference items. On the immediate test, the summary group had scored higher than the other two groups on new fact items, but scores did not significantly differ for groups on repeated inference items.

Reading Level

Reading level was highly significant for the delayed criterion test, F (8,222)= 5.62, $p<.0001$ with all four dependent measures significant at the .001 level. Again, high readers (22.21) and middle-level readers (18.02) scored significantly higher than low readers (12.90) on all four question types, F (1,113)= 3.07, $p<.05$. High readers scored significantly higher than middle-level readers on repeated fact, repeated inference, and new inference questions, F (1,113)= 3.07, $p<.05$. This finding differs from the immediate test where no significance between groups occurred on new inference items.

Question Type

The difference on overall performance on fact questions (9.23) and inference questions (8.94) was again statistically significant, F (1,120)= 99.62, $p<.001$. The correlation of

student scores on delayed fact questions with delayed inference questions was .67.

Interactions

A significant interaction for the delayed test was found on new inference items, F (4,113)= 2.91, $p<.02$.
Figure 1 shows that this interaction was primarily due to the poor achievement of high readers in the covert group.

Gain Scores

Differences between the immediate and delayed test scores were significant, F (1,120)= 139.99, $p<.001$. Univariate analysis were run using gain scores for all dependent variables. Scheffe's multiple comparison test found no significance for reading level.

Significant effects were found for practice condition on new inference and repeated inference items. On new inference items, there was a significant difference between the summary condition and the overt condition, F (1,113)= 3.07, $p<.05$. These results are difficult to interpret due to the interaction effects found for new inference questions. It does appear, however, that this significant gain score effect was primarily due to the difference in scores of the middle-level readers in these treatments.

Significant differences between practice conditions were found for the overt and summary conditions, and the covert and summary conditions on repeated inference items, F (4,133)= 3.07, $p<.05$. This effect appears to be due to the difference in scores of the high readers in each practice condition.

Discussion

In this study the summary treatment subjects displayed higher levels of recall on all new fact and new inference test items than either question treatment groups. It stands to reason that what the subjects in the summary condition remembered was a function of the cues provided for them by the experimenter during encoding. Tulving and Thompson (1973) found that the effectiveness of any retrieval cue was dependent on its being encoded with the material to be remembered. Summary subjects were given paraphrased concepts and cues which could be encoded simultaneously.

The interspersed questions required students in the covert and overt groups to utilize the information they had read. This

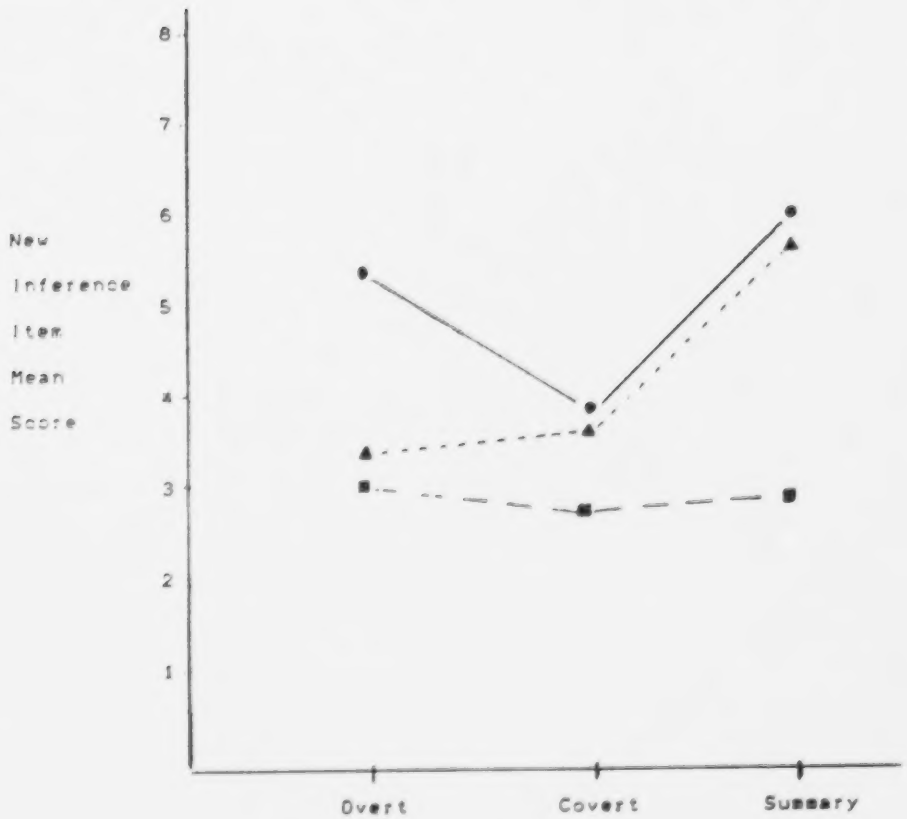

Figure 1. Practice condition by reading level interaction: Delayed Test

introduced a practice factor. Unlike many studies in the literature (Bourne & Haygood, 1959; Callantine & Warren, 1955), this study found practice in question form to have only a slight facilitative effect on achievement. Covert and overt practice groups were not found to perform significantly better than the summary group that received no questions or practice on specific test items. A post hoc error analysis found that overt treatment subjects who had selected the wrong answer for any inserted question in practice were more apt to select that same wrong answer on the posttest. The correct response was not selected on the posttest even though the students received immediate verbal feedback in practice indicating the correct response.

The overt subjects performed significantly higher than the covert subjects across all reading levels. Lack of compliance to practice condition by covert subjects may have accounted in part for these results. It is likely that these results vary according to the motivation of the students in the covert group.

The results of this study suggest that practice condition and question type may differentially affect learning and retention. Overt and covert practice facilitated recall of repeated factual items, whereas, summary subjects scored significantly higher on new fact and new inference items. As evidenced by total mean scores, allowing students to practice factual test items in treatment increased test scores on those exact items. However, this effect was not found for inference items. Recall of repeated inference items and other relevant content was not facilitated through the use of questions.

The Keenan et al (1978) study found that questions elicit pupil attention and direct it to specific content. In the research done by Allen (1970), subjects did better on questions relating to information they were asked about in adjunct questions. In this study, the practice of specific fact questions may have actually directed the students' attention away from other facts. Similarly, practice in answering inference questions did not better prepare those subjects in the covert and overt group to answer new inference questions, but again seemed to direct student attention from relevant content.

The summary condition scored significantly higher than the covert and overt groups on new fact items. These items were not practiced in any form by any treatment. Subjects in the covert and overt question groups may have been distracted from relevant content by reading only for answers to questions. This type of depressive effect of questions on recall was recognized in the Rickards and Denner (1979) study. In this study this effect was also found on inference questions. Repeated inference scores were similar for all treatments, however, the summary group scored significantly higher than both question groups on new inference items.

The importance of appropriate placement of questions is well established. Richards and Di Vista (1974) found that when questions were inserted after every two paragraphs, meaningful learning questions led to superior performance. This effect disappeared when questions were asked after four paragraphs. Results from this study show that questions asked after every paragraph did not increase student achievement and may have interferred with processing and encoding of new information.

The literature is far from conclusive about the effects of higher level questions. The nature of inference questions requires that a reader state a relationship between elements of a passage. This involves more complex cognitive processing and has proven a more difficult task, especially for low readers. In this study, fact scores were significantly higher than inference scores. However, inference questions had a slight facilitative effect on retention. This was exhibited by the difference in immediate and delayed test scores for fact and inference questions. Inference question scores remained similar on the immediate and delayed tests, whereas, scores for fact questions fell sharply on the delayed test. This is consistent with the Craik and Tulving (1975) study where conceptually based items, requiring greater depth of processing, were better retained than the items requiring recall operations.

The summary group was a highly effective treatment. On new fact items, new inference items, and repeated inference items the summary group scored consistently high. This held true across all reading levels for both immediate and delayed tests. The summary treatment highlighted facts and concepts in narrative form and reinforced only relevant content. The questioning treatments, whether overtly or covertly practiced, appear to have allowed encoding of distractors and incorrect responses. Therefore the results of this study would warn that questioning strategies are beneficial only to the extent that the correctness of the response can be controlled in a practice situation.

Treatment times varied dramatically among the practice conditions. The two question treatments were one hour and fifteen minutes long. The summary treatment took only fifty minutes. With this in mind, and comparing the overall immediate and delayed test scores, the summary practice condition was the most effective and efficient treatment for all level readers.

Reading level was significant across treatments. High readers scored equally well on fact and inference items. Medium and low readers generally scored higher on fact questions as compared to inference questions. These results are consistent with previous literature in this area and suggest that reading ability directly affects student competency in answering inference questions.

Overall gain scores for the three groups show that overt subjects' scores tended to remain more constant than those of the covert and summary subjects. Although immediate test scores for the overt group were not as high as the summary group, the overt participation appears to have facilitated long term retention.

On the delayed test a practice by reading level interaction was found for new inference items. As stated above, generally scores were lower on the delayed test. The covert group scored consistently lower on the delayed test across reading levels. However, the high readers in the overt treatment and the medium readers and high readers in the summary treatment scored significantly higher on the delayed test on new inference items. The interaction appears to be due to the overt and summary conditions that were especially effective, over time, for higher readers. Studies using delayed testing (Goldbeck & Campbell, 1962; Krumboltz & Weisman, 1962) have shown overt treatments to be more effective than covert treatments. However, little previously has been reported about summary treatments.

From the immediate measure to the delayed measure repeated items fell more than new items. It appears that practice of items in question form leads to short term retention of answers. Immediate results of repeated items were higher due to a practice factor. However, delayed test results show that practice of specific answers is far less effective over time than general knowledge of the content itself.

The results of this study suggest differential relationships between two question treatments and the summary treatment with respect to performance on repeated items and performance on new items. This is of importance for instructional planning and program development. The present study indicates that further research in this area is needed to better determine the nature of these relationships and implications in regard to affectiveness of the different practice conditions with respect to factual and inferential learning. Oral summaries should continue to be considered as viable alternatives to questioning strategies and deserve further investigation.

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